10. Groundwater Resources

10.1 Introduction

This chapter provides a description of the groundwater resources setting for the Extended, Secondary, and Primary study areas. Descriptions and maps of these three study areas are provided in Chapter 1 Introduction. Groundwater resources refer to the groundwater aquifer system(s) including groundwater infrastructure (i.e., existing groundwater wells and their distribution facilities in the vicinity of the Project).

The regulatory setting for groundwater resources is discussed briefly in this chapter, and is presented in greater detail in Chapter 4 Environmental Compliance and Permit Summary.

This chapter focuses primarily on the Primary Study Area. Potential impacts in the Secondary and Extended study areas were evaluated and discussed qualitatively. Potential local and regional impacts from constructing, operating, and maintaining the alternatives were described and compared to applicable significance thresholds. Mitigation measures are provided for identified significant or potentially significant impacts, where appropriate.

10.2 Environmental Setting/Affected Environment

Throughout the State, the availability and predictability of groundwater for withdrawal is influenced by the geology and topography of the region, because groundwater may occur in alluvial sediment or fractured rock aquifers. The characteristics of these aquifers are described below.

Alluvial sediment aquifers occur primarily in valley areas where the lower elevation of the ground surface has provided a location for eroded sediment to collect and accumulate. Groundwater is collected and stored in the pore spaces between the pieces of eroded material. For example, groundwater is found between the stones in a gravel bed. The groundwater production associated with alluvial sediment aquifers varies from very little to large quantities based on the composition of the sediment and availability of recharge water. Wells in alluvial sediment aquifers provide water for many uses including domestic, irrigation, industrial, environmental, and public water supply.

Fractured rock aquifers are found primarily in mountainous regions where topography prevents the accumulation of significant amounts of eroded material. Groundwater collects and is stored in the fractures of the solid rock formations. Fractured rock aquifers are generally considered to produce less groundwater and to be less predictable water sources than alluvial aquifers. Wells in fractured rock aquifers provide water for many of the same uses as the wells in alluvial sediment aquifers.

10.2.1 Extended Study Area

10.2.1.1 Hydrogeology and Groundwater Resources

California is divided into 10 hydrologic regions based on surface water hydrology. Brief descriptions of the groundwater hydrogeology and resources within the hydrologic regions where changes in water supply distribution may occur as a result of Project implementation are provided below.

North Coast Hydrologic Region

Groundwater development in the North Coast Hydrologic Region occurs in areas of lower ground surface elevation and slope where eroded material can be deposited and accumulate. These include areas along the coast, near the mouths of or adjacent to major rivers, and in the inland valleys. Groundwater reliability varies significantly from area to area (DWR, 2003).

San Francisco Bay Hydrologic Region

Groundwater development in the San Francisco Bay Hydrologic Region is limited because coarse alluvial sediments where fresh groundwater is stored are thin in many areas. In more heavily used basins, fresh groundwater sediments are moderately thick. Groundwater availability varies significantly from area to area (DWR, 2003).

Central Coast Hydrologic Region

Groundwater development in the Central Coast Hydrologic Region is extensive. Aquifer reliability and storage vary greatly, ranging from large alluvial valleys with thick aquifer systems to small inland valleys and coastal terraces where large-scale groundwater production is not possible (DWR, 2003).

South Coast Hydrologic Region

Groundwater development in the South Coast Hydrologic Region is extensive. Groundwater is produced almost exclusively from alluvial aquifer systems. Aquifer production can be as high as thousands of gallons per minute (gpm) in large municipal wells (DWR, 2003).

Sacramento River Hydrologic Region

Groundwater development in the Sacramento River Hydrologic Region is widespread. The Sacramento Valley is considered to be one of the most productive aquifer systems in the state. Extensive deposition of alluvial material in the Sacramento Valley has created large, reliable, and productive aquifer systems. Groundwater production and reliability are less predictable from the alluvial sediments in mountain basins, but many produce significant amounts of groundwater. Small scale production is achieved from fractured rock aquifer systems outside of and along the edges of the alluvial basins (DWR, 2003).

San Joaquin River Hydrologic Region

Groundwater development in the San Joaquin River Hydrologic Region is extensive. Groundwater is produced from thick beds of alluvium and consolidated rocks. Groundwater production is generally high, ranging between 300 and 5,000 gpm (DWR, 2003).

Tulare Lake Hydrologic Region

Groundwater development in the Tulare Lake Hydrologic Region is extensive. Groundwater is produced from thick beds of alluvium in the San Joaquin Valley subbasins. The maximum thickness of freshwater aquifer deposits is approximately 4,400 feet. Groundwater production in these areas generally ranges from 300 to 4,000 gpm. Aquifer deposits in the smaller basins surrounding the San Joaquin Valley are thinner and generally produce less groundwater, averaging less than 500 gpm (DWR, 2003).

South Lahontan Hydrologic Region

Groundwater development in the South Lahontan Hydrologic Region is limited to populated areas. Groundwater is produced almost exclusively from alluvial sediments, and production varies greatly from basin to basin (DWR, 2003).

Colorado River Hydrologic Region

Groundwater is produced from alluvial aquifer systems in many of the region's subbasins. The thickness and production associated with the various aquifers varies greatly from basin to basin. Some aquifers can produce thousands of gallons per minute to properly designed wells (DWR, 2003).

10.2.2 Secondary Study Area

10.2.2.1 Hydrogeology and Groundwater Resources

The Secondary Study Area includes small portions of the North Coast and San Francisco Bay hydrologic regions and most of the Sacramento River Hydrologic Region. More detailed descriptions of the geologic setting and formations for the Secondary Study Area are included in Chapter 16 Geology, Minerals, Soils, and Paleontology.

North Coast Hydrologic Region

The portion of the North Coast Hydrologic Region that is included in the Secondary Study Area consists of areas surrounding Trinity Lake, Lewiston Lake, the Clear Creek Tunnel, the Trinity River, and the Klamath River downstream of the Trinity River. North and northeast of Redding, the valley meets the base of the Klamath Mountain Range.

In general, the geologic setting for this area consists of ancient marine-type sedimentary rocks uplifted by massive granitic intrusions. Groundwater is produced from eroded and redeposited material that often collects along stream and river channels and in valley areas within the mountain region. Some groundwater is also produced from fractured hard rock aquifers. Groundwater production in the mountain region is less predictable and usually less productive than in most parts of the valley because the geologic material storing the groundwater is much more limited.

San Francisco Bay Hydrologic Region

The portion of the San Francisco Bay Hydrologic Region that is included in the Secondary Study Area consists of areas surrounding the Sacramento-San Joaquin Delta (Delta), Suisun Bay, San Pablo Bay, and San Francisco Bay.

In general, the geologic setting for these areas consists of alluvial deposits of material eroded from rocks higher in the watersheds that were transported and deposited by rivers and streams feeding into the Region. Groundwater is produced from these alluvial sediments. Groundwater production varies from area to area because coarse sediments that store groundwater vary in thickness.

Sacramento River Hydrologic Region

The northern Sacramento Valley is bordered by the Klamath Mountain on the north, a portion of the Northern Coast Ranges to the west, and bordered on the east by the southern part of the Cascade Range and northern part of the Sierra Nevada. The valley is approximately 12 miles wide near the City of Red Bluff and approximately 38 miles wide south of the Sutter Buttes. The length of the valley is roughly

60 miles. Included in the Sacramento River Hydrologic Region are Shasta Lake, Keswick Reservoir, the Sacramento River, Spring Creek, Clear Creek, Whiskeytown Lake, Lake Oroville, the Thermalito Complex, the Feather River, Sutter Bypass, Yolo Bypass, Folsom Lake, Lake Natoma, and the American River.

The northern Sacramento Valley is underlain by an extensive alluvial aquifer system. Along the edges of the basin, near the base of the mountains, groundwater is also produced from limited fractured rock aquifers. In areas outside of the Sacramento Valley, groundwater occurs in alluvium deposited in smaller valleys and along stream and river channels. Groundwater is also produced from fractured rock areas and in the Cascade Range from sand and gravel aquifers found between ancient lava flows.

The boundaries of the part of the groundwater basin within the Secondary Study Area are formed by the foothills of the Sierra and Cascade mountain ranges to the east, the Coast Range to the west, and Klamath Mountains to the northwest. The region extends south from the Modoc Plateau and Cascade Range at the Oregon border, to the Sacramento-San Joaquin Delta (DWR, 2003).

The primary fresh groundwater-bearing geologic formations in the northern Sacramento Valley are the Tuscan, Tehama, and Laguna Formations. The valley stratigraphy is oriented approximately west to east between the cities of Willows and Oroville. The relationship between the geologic formations is depicted on this cross-section and this relationship is basically consistent through much of the valley.

The Tuscan Formation is derived primarily from mud flow and reworked volcanic deposits. The origin is near Lassen Peak, north and east of the Secondary Study Area. The mud flows of the Tuscan can be seen in outcrops on the eastern side of the valley from north of Oroville to Redding. The flows continued into the valley as far west as where Interstate 5 (I-5) is located in some locations, but were buried with more recent alluvial material. The composition of the Tuscan Formation in the valley consists of layers of gravel, sand, silt, and clay.

The Tehama Formation is derived from material eroded from the Coast Range and Klamath Mountains. The rolling hills formed by the Tehama Formation can be seen nearly uninterrupted from Cottonwood in the north to well beyond the southern end of the Secondary Study Area. North of Cottonwood, the Tehama Formation is exposed across the valley floor from Palo Cedro in the east to the Coast Range foothills in the west. Similar to the Tuscan Formation, the Tehama Formation is present in both surface exposures and in the subsurface of the valley where it is overlain by more recent alluvial material. In the subsurface, the Tehama Formation extends east beyond the Sacramento River in most locations within the Secondary Study Area. The composition of the Tehama Formation in the valley consists of layers of gravel, sand, silt, and clay.

The Laguna Formation is composed of material eroded from the Sierra Nevada. Similar to the Tehama Formation, the Laguna Formation is exposed at the surface in rolling hills. Exposures of the Laguna Formation can be seen at the base of the Sierra Nevada on the east side of the valley between Oroville and Sacramento. In the subsurface, the Laguna Formation extends west to approximately the Sacramento River. The Laguna Formation consists of primarily layers of gravel, sand, and silt.

Recent alluvial formations including the Red Bluff, Riverbank, Modesto, and Basin deposits cover the Tuscan, Tehama, and Laguna formations throughout much of the valley with up to 200 feet of gravel, silt, and clay. In localized areas, the recent alluvium can be a significant source of groundwater for domestic, agricultural, and public use, but generally these units provide a modest amount of water to primarily domestic users (DWR, 2003).

10.2.3 Primary Study Area

10.2.3.1 Hydrogeology and Groundwater Resources

Sites Reservoir Inundation Area, Dams, Recreation Areas, Roads and South Bridge, Sites Reservoir Inlet/Outlet Structure, Sites Pumping/Generating Plant, Tunnel from Sites Pumping/Generating Plant to Site Reservoir Inlet/Outlet Structure, and Sites Electrical Switchyard

Local Hydrogeology

The proposed location for the Sites Reservoir Inundation Area would completely inundate both the Funks and Antelope Creek groundwater basins. These groundwater basins consist primarily of shallow (generally less than 100 feet) alluvial deposits (DWR, 2003). These alluvial deposits are Late Quaternary (8,000 years ago) in age and occur within the reservoir footprint, primarily along the valleys of Stone Corral, Antelope, Funks, and Grapevine creeks. The deposits consist of fine-grained sands, silts, and clays occurring as stream channel and localized floodplain deposits.

Most of the wells in these groundwater basins are designed to produce water from the underlying rock formation (the Great Valley Sequence). The Great Valley Sequence is comprised of marine, clastic sedimentary rock consisting of siltstone, shale, sandstone, and conglomerate. The sequence has a maximum thickness of 15,000 feet. Groundwater resources from this formation are limited due to poor water bearing and water quality characteristics. More detailed descriptions of the geologic setting and formations are included in Chapter 16 Geology, Minerals, Soils, and Paleontology.

Local Groundwater Infrastructure

As of 2009, there are approximately 26 wells that have been constructed within an approximate one-mile radius of the Sites Reservoir footprint. Table 10-1 presents a summary of well data for these wells including the number of wells, well depth, well use, depth to water, and well yield, for the appropriate Township, Range, and Section. The data presented here are from the California Department of Water Resources (DWR) well completion report data set. All data are reported as it was submitted by the well driller at the time of drilling and development. None of this data was verified by DWR staff and conditions may have changed since the time of drilling. Additional wells may be present in the study area that were not reported to DWR by the driller.

As shown in Table 10-1, 10 wells are constructed to a depth of 100 feet or greater, the deepest well being 201 feet deep. Well yields in the area are low, ranging from a high of 60 gpm to a low of zero or no measurable yield, and averaging 14 gpm. The depth to water in the area, based on well completion reports, ranges from one foot to 30 feet below ground surface, with an average depth of approximately 17 feet (DWR, 2011).

Table 10-2 provides a summary of well data for each type of well (e.g., domestic or irrigation), as reported on well completion reports submitted to DWR. As shown, half of the wells in the area are domestic wells constructed to depths of approximately 77 feet with yields averaging approximately 15 gpm.

Stock wells are the second most common well type in the area constructed to depths of approximately 85 feet. Well yields from stock wells average approximately 18 gpm.

Table 10-1
Wells Located Within a One-Mile Radius of the Proposed Sites Reservoir Footprint

Township, Range, and Section Number	Number of Wells within Section	Well Depth (feet)	Well Use	Depth to Water (Feet)*	Well Yield (gpm)*
T16N R04W Sec 06	1	201	Stock	20	20
T16N R04W Sec 19	2	119	Domestic	21	15
		31	Domestic	16	15
T16N R05W Sec 12	2	85	Irrigation	NA	NA
		75	Stock	NA	0
T16N R05W Sec 23	1	86	Stock	4	8
T16N R05W Sec 24	1	140	Domestic	12	7
T17N R04W Sec 06	1	20	Stock	10	60
T17N R04W Sec 08	1	105	Stock	7	NA
T17N R04W Sec 16	1	124	Domestic	17	12
T17N R04W Sec 19	1	29	Stock	18	2
T17N R04W Sec 20	13	84	Domestic	10	10
		37	Domestic	18	5
		47	Domestic	NA	NA
		45	Domestic	26	NA
		28	Domestic	NA	NA
		45	Domestic	NA	NA
		200	Industrial	30	3
		100	Industrial	17	20
		70	Domestic	30	50
		160	Domestic	22	25
T17N R04W Sec 31	1	60	Stock	20	10
T17N R05W Sec 24	1	80	Domestic	30	5
T18N R05W Sec 13	1	100	Domestic	10	10
T18N R05W Sec 15	1	100	Stock	10	10
T18N R05W Sec 25	1	38	Domestic	1	NA

*Depth to water and well yield values are based on estimates provided by the driller at the time of drilling in well completion reports.

Notes:

Further evaluation of well completion report data thru 2011 indicates no additional well drilling between 2009 and 2011. DWR well completion report data set may not include all wells.

gpm = gallons per minute
NA = Not Available

Source: DWR, 2011.

Table 10-2
Summary of Well Data By Well Type for Wells Located within a One-Mile Radius of the Sites Reservoir Footprint

Well Type	Number of Wells	Average Well Depth (feet)	Average Depth of Water (feet)	Average Well Yield (gpm)
Domestic	15	77	17.75	15.4
Irrigation	1	85	NA	NA
Industrial	2	150	23.5	11.5
Stock	8	85	12.7	18.33
Other*	4	28	NA	NA

Notes:

Further evaluation of well completion report data thru 2011 indicates no additional well drilling between 2009 and 2011. DWR well completion report data set may not include all wells.

gpm = gallons per minute
NA = Not Available

Source: DWR, 2011.

Holthouse Reservoir Complex, Holthouse Reservoir Electrical Switchyard, Tehama-Colusa Canal, Field Office Maintenance Yard, Terminal Regulating Reservoir Pipeline, and Terminal Regulating Reservoir Pipeline Road

Local Hydrogeology

The Holthouse Reservoir Complex and Holthouse Reservoir Electrical Switchyard (proposed location), T-C Canal (proposed modifications), and the Field Office Maintenance Yard, TRR Pipeline, and TRR Pipeline Road would overlie Great Valley Sequence and Holocene basin deposits. The Great Valley Sequence is comprised of marine clastic sedimentary rock consisting of siltstone, shale, sandstone, and conglomerate. The sequence has a maximum thickness of 15,000 feet. Groundwater resources in this area are limited due to the poor water bearing and water quality characteristics.

The basin deposits consist of silt and clay deposited in low-lying floodplain areas adjacent to major streams. Permeability of basin deposits is generally low and groundwater occurs in limited quantities.

Local Groundwater Infrastructure

As of 2009, there are approximately three wells that have been constructed and one test hole drilled within an approximate one-mile radius of the proposed Holthouse Reservoir Complex. Table 10-3 presents a summary of well data for these wells including the number of wells, well depth, well use, depth to water, and well yield, for the appropriate township, range, and section. The data presented here are from the DWR well completion report data set. All data are reported as it was submitted by the well driller at the time of drilling and development. None of this data was verified by DWR staff and conditions may have changed since the time of drilling. Additional wells may be present in the study area that were not reported to DWR by the driller.

The constructed well depths ranged from 124 feet to 240 feet and the reported well yields were low at 12 and 14 gpm. A depth to water measurement was only reported on the well completion report for two wells, and those measurements were 20 and 41 feet below ground surface. One well was drilled for industrial uses, and the other two for domestic water supplies (DWR, 2011).

Table 10-3
Wells Located Within a One-Mile Radius of the Proposed Holthouse Reservoir Complex and TRR Pipeline

Section Number	Number of Wells within Section	Well Depth (feet)	Well Use	Depth to Water (Feet)*	Well Yield (gpm)*
T17N R04W Sec 11	1	240	Industrial	20	14
T17N R04W Sec 12	2	80	Domestic	41	11
		240	Test Hole	NA	NA
T17N R04W Sec 16	1	124	Domestic	NA	12

*Depth to water and well yield values are based on estimates provided by the driller at the time of drilling in well completion reports.

Notes:

Further evaluation of well completion report data thru 2011 indicates no additional well drilling between 2009 and 2011. DWR well completion report data set may not include all wells.

gpm = gallons per minute
NA = Not Available

Source: DWR, 2011.

Glenn-Colusa Irrigation District Canal

Local Hydrogeology

The GCID Canal (proposed modifications) crosses deposits of the Riverbank Formation and basin deposits. The Riverbank Formation is composed of terrace deposits that consist of poorly consolidated gravel, sand, and silt. These deposits are found along the Sacramento River and adjacent tributaries and are up to 200 feet thick. Permeability of the Riverbank Formation is moderate to high, and yields of domestic wells are moderate.

Basin deposits consist of silt and clay deposited in low-lying floodplain areas adjacent to major streams. Permeability of basin deposits is generally low, and groundwater occurs in limited amounts.

Delevan Pipeline, Delevan Transmission Line, Delevan Pipeline Electrical Switchyard, Delevan Pipeline Intake Facilities, and Delevan Discharge Facility

Local Hydrogeology

The Delevan Pipeline, Delevan Transmission Line, Delevan Pipeline Electrical Switchyard, Delevan Pipeline Intake Facilities, and Delevan Discharge Facility would overlie the Great Valley Sequence, Riverbank Formation, and basin deposits.

The Great Valley Sequence is comprised of marine, clastic sedimentary rock consisting of siltstone, shale, sandstone, and conglomerate. The sequence has a maximum thickness of 15,000 feet. Groundwater resources from this formation are limited due to poor water bearing and water quality characteristics.

The Riverbank Formation is composed of terrace deposits that consist of poorly consolidated gravel, sand, and silt. These deposits are found along the Sacramento River and adjacent tributaries and are up to 200 feet thick. Permeability of the Riverbank Formation is moderate to high, and yields of domestic wells are moderate.

Basin deposits consist of silt and clay deposited in low-lying floodplain areas adjacent to major streams. Permeability of basin deposits is generally low, and groundwater occurs in limited amounts.

Local Groundwater Infrastructure

As of 2009, there are approximately 35 wells that have been constructed within approximately one mile of the Delevan Pipeline construction area. Table 10-4 presents a summary of well data for these wells including the number of wells, well depth, well use, depth to water, and well yield, for the appropriate township, range, and section. The data presented here are from the DWR well completion report data set. All data are reported as it was submitted by the well driller at the time of drilling and development. None of this data was verified by DWR staff and conditions may have changed since the time of drilling. Additional wells may be present in the study area that were not reported to DWR by the driller.

Table 10-4
Wells Located Within One-Mile of the Delevan Pipeline and Associated Facilities

Section Number	Number of Wells within Section	Well Depth (feet)	Well Use	Depth to Water (Feet)*	Well Yield (gpm)*
T17N R02W Sec 07	2	119	Domestic	NA	NA
		180	Domestic	NA	NA
T17N R02W Sec 08	2	260	Domestic	13	60
		194	Domestic	NA	NA
T17N R02W Sec 09	5	812	Irrigation	24	8300
		280	Monitoring	NA	NA
		540	Monitoring	NA	NA
		863	Monitoring	NA	NA
		18	Other	NA	NA
T17N R02W Sec 11	3	260	Irrigation	NA	NA
		360	Irrigation	5	5000
		260	Domestic	NA	NA
T17N R02W Sec 12	4	600	Irrigation	NA	NA
		630	Domestic	23	5105
		350	Unknown	NA	NA
		760	Irrigation	NA	5000
T17N R03W Sec 07	2	145	Domestic	NA	NA
		142	Unknown	NA	NA
T17N R03W Sec 08	3	240	Domestic	6	200
		70	Domestic	NA	NA
		450	Domestic	NA	NA
T17N R03W Sec 09	6	175	Domestic	NA	NA
		330	Unknown	NA	NA
		200	Domestic	NA	NA
		192	Domestic	NA	NA
		331	Domestic	NA	NA
		232	Irrigation	NA	NA
T17N R03W Sec 10	1	200	Domestic	NA	NA
T17N R03W Sec 11	3	292	Domestic	NA	NA
		103	Domestic	NA	NA
		120	Domestic	NA	NA

Table 10-4
Wells Located Within One-Mile of the Delevan Pipeline and Associated Facilities

Section Number	Number of Wells within Section	Well Depth (feet)	Well Use	Depth to Water (Feet)*	Well Yield (gpm)*
T17N R03W Sec 12	4	560	Domestic	30	NA
		284	Domestic	NA	NA
		675	Domestic	NA	NA
		13	Unknown	NA	NA

*Depth to water and well yield values are based on estimates provided by the driller at the time of drilling in well completion reports.

Notes:

Further evaluation of well completion report data thru 2011 indicates no additional well drilling between 2009 and 2011. DWR well completion report data set may not include all wells.

gpm = gallons per minute
NA = Not Available

Source: DWR, 2011.

The well depths ranged from 13 feet to 863 feet. The reported data for well yields were limited, but ranged between 60 and 8,300 gpm. The depth to water measurements ranged between five and 30 feet below ground surface, with an average depth of 17 feet. The intended use of the wells reported on the well completion reports is as follows: 20 domestic, seven irrigation, four unknown, three monitoring, and one other (DWR, 2011).

Terminal Regulating Reservoir, Terminal Regulating Reservoir Pumping/Generating Plant, Terminal Regulating Reservoir Electrical Switchyard, and Glenn-Colusa Irrigation District Canal Connection to the Terminal Regulating Reservoir

Local Hydrogeology

The TRR, TRR Pumping/Generating Plant, TRR Electrical Switchyard, and GCID Canal Connection to the TRR would overlie Riverbank Formation and basin deposits.

The Riverbank Formation is composed of terrace deposits that consist of poorly consolidated gravel, sand, and silt. These deposits are found along the Sacramento River and adjacent tributaries and are up to 200 feet thick. Permeability of the Riverbank Formation is moderate to high, and yields of domestic wells are moderate.

Basin deposits consist of silt and clay deposited in low-lying floodplain areas adjacent to major streams. Permeability of basin deposits is generally low, and groundwater occurs in limited amounts.

Local Groundwater Infrastructure

As of 2009, there are approximately 10 wells that have been constructed within an approximate one-mile radius of the proposed TRR. Table 10-5 presents a summary of well data for these wells including the number of wells, well depth, well use, depth to water, and well yield, for the appropriate township, range, and section. The data presented here are from the DWR well completion report data set. All data are reported as it was submitted by the well driller at the time of drilling and development. None of this data was verified by DWR staff and conditions may have changed since the time of drilling. Additional wells may be present in the study area that were not reported to DWR by the driller.

Table 10-5
Wells Located Within a One-Mile Radius of the Terminal Regulating Reservoir

Section Number	Number of Wells within Section	Well Depth (feet)	Well Use	Depth to Water (Feet)*	Well Yield (gpm)*
T17N R03W Sec 05	1	130	Domestic	4	NA
T17N R03W Sec 06	1	105	Domestic	20	50
T17N R03W Sec 07	2	145	Domestic	6	NA
		142	Unknown	NA	NA
T17N R03W Sec 08	3	240	Domestic	6	200
		70	Domestic	17	NA
		151	Domestic	20	NA
T17N R03W Sec 17	2	400	Domestic	8	200
		100	Domestic	20	NA
T17N R03W Sec 18	1	160	Domestic	12	70

*Depth to water and well yield values are based on estimates provided by the driller at the time of drilling in well completion reports.

Notes:

Further evaluation of well completion report data thru 2011 indicates no additional well drilling between 2009 and 2011. DWR well completion report data set may not include all wells.

gpm = gallons per minute
NA = Not Available

Source: DWR, 2011.

The well depths ranged from 70 feet to 400 feet. The reported data for well yields were limited, but ranged between 50 and 200 gpm. The depth to water measurements ranged between four and 20 feet below ground surface with an average depth of 12.5 feet. Nine of the 10 wells were drilled for domestic water supply. The intended use of the tenth well is unknown (DWR, 2011).

Project Buffer

Local Hydrogeology

The Project Buffer would surround groupings of Project facilities. The Project Buffer, therefore, would overlie the same formations and deposits as described for each of the Project facilities that are surrounded by the Project Buffer.

Local Groundwater Infrastructure

The Project Buffer extends from the Project facility footprints to the edge of the nearest land parcel; the distance of the Project Buffer boundary from any facility footprint is less than one mile. The well data presented for the Project facilities includes all wells located within one mile of the facilities and, therefore, includes wells that are located within the buffer boundary.

10.3 Environmental Impacts/Environmental Consequences

10.3.1 Regulatory Setting

Groundwater resources are regulated at the federal, State, and local levels. Management of groundwater resources occurs at the local level. Provided below is a list of the applicable regulations. These regulations are discussed in detail in Chapter 4 Environmental Compliance and Permit Summary of this EIR/EIS.

10.3.1.1 Federal Plans, Policies, and Regulations

- National Environmental Policy Act
- Federal Safe Drinking Water Act
- Federal Antidegradation Policy
- Clean Water Act

10.3.1.2 State Plans, Policies, and Regulations

- California Environmental Quality Act

10.3.1.3 Regional and Local Plans, Policies, and Regulations

The State of California does not have a statewide regulatory permit process for groundwater extraction. Groundwater management has remained primarily a local responsibility with relatively little control exerted by the California Legislature. The authority to implement some sort of groundwater management practice has been provided to established local water agencies, special act districts, and counties. The authority of these districts varies greatly with the specific authorization that established the district – from granting the authority to establish a groundwater management plan to (in a few cases) monitoring and limiting extraction during overdraft conditions (DWR 2003).

Many of the counties within the Extended Study Area, and the majority of the counties in the Secondary Study Area, have established groundwater ordinances. Within the Primary Study Area, Colusa and Glenn counties require permits for pumping groundwater for export or for substituting groundwater for surface water that was exported. However, these groundwater ordinances do not pertain to activities related to the Project because no groundwater would be extracted as part of the Project.

10.3.2 Evaluation Criteria and Significance Thresholds

Significance criteria represent the thresholds that were used to identify whether an impact would be significant. Appendix G of the *CEQA Guidelines* suggests the following evaluation criterion for hydrology and water quality that is relevant to groundwater resources:

Would the Project:

- Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?

The evaluation criteria used for this impact analysis represent a combination of the Appendix G criteria and professional judgment that considers current regulations, standards, and/or consultation with agencies, knowledge of the area, and the context and intensity of the environmental effects, as required pursuant to NEPA. For the purposes of this analysis, an alternative would result in a significant impact if it would result in any of the following:

- Substantial depletion of groundwater supplies or substantial interference with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of preexisting nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted).

- Increases in groundwater levels such that there would be adverse effects to environmental conditions, existing land uses, or planned uses for which permits have been granted.

10.3.3 Impact Assessment Assumptions and Methodology

10.3.3.1 Assumptions

The following assumptions were made regarding Project-related construction, operation, and maintenance impacts to groundwater resources:

- Direct Project-related construction, operation, and maintenance activities would occur in the Primary Study Area.
- Direct Project-related operational effects would occur in the Secondary Study Area.
- The only direct Project-related construction activity that would occur in the Secondary Study Area is the installation of an additional pump into an existing bay at the Red Bluff Pumping Plant.
- The only direct Project-related maintenance activity that would occur in the Secondary Study Area is the sediment removal and disposal at the two intake locations (i.e., GCID Canal Intake and Red Bluff Pumping Plant).
- No direct Project-related construction or maintenance activities would occur in the Extended Study Area.
- Direct Project-related operational effects that would occur in the Extended Study Area are related to San Luis Reservoir operation, increased reliability of water supply to agricultural, municipal, and industrial water users; and the provision of an alternate Level 4 wildlife refuge water supply. Indirect effects to the operation of certain facilities that are located in the Extended Study Area, and indirect effects to the consequent water deliveries made by those facilities, would occur as a result of implementing the alternatives.
- The existing bank protection located upstream of the proposed Delevan Pipeline Intake/Discharge facilities would continue to be maintained and remain functional.
- No additional channel stabilization, grade control measures, or dredging in the Sacramento River at or upstream of the Delevan Pipeline Intake/Discharge Facilities would be required.

10.3.3.2 Methodology

A combination of data, published reports, and professional experience with activities similar to those proposed was used to evaluate the potential impacts to groundwater resources from the alternatives. The data (detailed below) were used to determine the existing groundwater infrastructure, identify and estimate the aquifer properties of the underlying geologic material, and anticipate potential impacts that could result from Project-related activities in the three study areas.

The Extended and Secondary study area impact assessments relied on hydrologic and operational modeling performed using CALSIM II, which provided monthly river flows, and reservoir water surface elevations derived from monthly river flows and end-of-month reservoir storages, for the period of simulation extending from water year 1922 through 2003 (82-year simulation period). Detailed discussion of the CALSIM II model is provided in Appendix 6B. These modeling results were used in combination with professional judgment to assess the potential impacts of operation of the alternatives on groundwater resources.

DWR Bulletin 118-03 (DWR, 2003) was referenced to identify the groundwater basins within the Extended, Secondary, and Primary study areas, and to determine in more detail the aquifer properties of the geologic material within those basins.

A survey of DWR well completion report records (DWR, 2011) was conducted to determine the number, use, and depth of wells in the Primary Study Area. The well completion reports also provided general information regarding the geology and aquifer properties of the geologic formations encountered by the well drilling activities.

Previously completed projects, including the Thermalito Afterbay, and their resulting impacts were evaluated to determine the type and severity of impacts that might result in the Primary Study Area from proposed Project-related activities that would impound water.

10.3.4 Topics Eliminated from Further Analytical Consideration

No Project facilities or topics that are included in the significance criteria listed above were eliminated from further consideration in this chapter.

10.3.5 Impacts Associated with the No Project/No Action Alternative

10.3.5.1 Extended Study Area – No Project/No Action Alternative

Construction, Operation, and Maintenance Impacts

Agricultural, Municipal, Industrial, and Wildlife Refuge Water Use

Impact GW Res-1: Substantial Depletion of Groundwater Supplies or Substantial Interference with Groundwater Recharge Resulting in a Net Deficit in Aquifer Volume or a Lowering of the Local Groundwater Table Level, Causing Effects on Existing Land Uses or Planned Uses

The No Project/No Action Alternative includes implementation of projects and programs being constructed, or those that have gained approval, as of June 2009. The impacts of these projects have already been evaluated on a project-by-project basis, pursuant to CEQA and/or NEPA, and their potential for impacts to groundwater levels (either decrease or increase) has been addressed in those environmental documents. Therefore, **there would not be a substantial adverse effect** resulting in the depletion of groundwater resources, when compared to Existing Conditions.

Population growth is expected to occur in California throughout the period of Project analysis (i.e., 100 years), and is included in the assumptions for the No Project/No Action Alternative. A larger human population could be expected to cause increased demand for groundwater resources. Groundwater extraction has exceeded groundwater recharge in several areas of the Sacramento and San Joaquin hydrologic regions. Continued groundwater extraction at rates that exceed groundwater recharge **could have a substantial adverse effect** on groundwater resources, when compared to Existing Conditions.

Impact GW Res-2: Increases in Groundwater Levels Resulting in Adverse Effects to Environmental Conditions and/or Existing Land Uses or Planned Uses

Refer to the **Impact GW Res-1** discussion.

San Luis Reservoir

Impact GW Res-1: Substantial Depletion of Groundwater Supplies or Substantial Interference with Groundwater Recharge Resulting in a Net Deficit in Aquifer Volume or a Lowering of the Local Groundwater Table Level, Causing Effects on Existing Land Uses or Planned Uses

With implementation of the No Project/No Action Alternative, San Luis Reservoir would continue to experience water level fluctuations similar to Existing Conditions. Groundwater recharge would not be expected to be substantially adversely affected by continued fluctuations. Therefore, continued fluctuations in water levels at San Luis Reservoir **would not have a substantial adverse effect** on groundwater resources, when compared to Existing Conditions.

Impact GW Res-2: Increases in Groundwater Levels Resulting in Adverse Effects to Environmental Conditions and/or Existing Land Uses or Planned Uses

Refer to the **Impact GW Res-1** discussion.

10.3.5.2 Secondary Study Area – No Project/No Action Alternative

<u>Construction, Operation, and Maintenance Impacts</u>

Trinity Lake, Lewiston Lake, Trinity River, Klamath River Downstream of the Trinity River, Whiskeytown Lake, Spring Creek, Shasta Lake, Sacramento River, Keswick Reservoir, Clear Creek, Lake Oroville, Thermalito Complex (Thermalito Diversion Pool, Thermalito Forebay, and Thermalito Afterbay), Feather River, Sutter Bypass, Yolo Bypass, Folsom Lake, Lake Natoma, American River, Sacramento-San Joaquin Delta, Suisun Bay, San Pablo Bay, San Francisco Bay

Impact GW Res-1: Substantial Depletion of Groundwater Supplies or Substantial Interference with Groundwater Recharge Resulting in a Net Deficit in Aquifer Volume or a Lowering of the Local Groundwater Table Level, Causing Effects on Existing Land Uses or Planned Uses

Refer to the **Impact GW Res-1** discussion for the Extended Study Area. Population growth could result in increased use of existing aquifers. Groundwater level data indicate that groundwater extraction has likely exceeded groundwater recharge in several areas of the Sacramento River Hydrologic Region. These areas are scattered throughout the region; there are areas with higher groundwater overdraft rates in Glenn County, and south of the city of Williams in Colusa County. These areas are located in the Sacramento Valley floor groundwater basins. If the No Project/No Action Alternative is implemented, the overdraft rates would likely continue and possibly increase. Continued groundwater extraction at rates that exceed groundwater recharge **could have a substantial adverse effect** on groundwater resources, when compared to Existing Conditions.

Impact GW Res-2: Increases in Groundwater Levels Resulting in Adverse Effects to Environmental Conditions and/or Existing Land Uses or Planned Uses

Refer to the **Impact GW Res-1** discussion for the Extended Study Area.

10.3.5.3 Primary Study Area – No Project/No Action Alternative

Construction, Operation, and Maintenance Impacts

Impact GW Res-1: Substantial Depletion of Groundwater Supplies or Substantial Interference with Groundwater Recharge Resulting in a Net Deficit in Aquifer Volume or a Lowering of the Local Groundwater Table Level, Causing Effects on Existing Land Uses or Planned Uses

Refer to the **Impact GW Res-1** discussion for the Extended Study Area. In addition, projects considered within the No Project/No Action Alternative are not located within the Primary Study Area, and therefore, **would not have a substantial adverse effect** on groundwater resources, when compared to Existing Conditions. With implementation of the No Project/No Action Alternative, local landowners and tenants would continue to use groundwater for domestic use and for crop irrigation. Because population growth is projected to be minimal in this area, groundwater extraction would not be expected to increase substantially. Therefore, continued groundwater use in the Primary Study Area with implementation of the No Project/No Action Alternative **would not have a substantial adverse effect** on groundwater resources, when compared to Existing Conditions.

Impact GW Res-2: Increases in Groundwater Levels Resulting in Adverse Effects to Environmental Conditions and/or Existing Land Uses or Planned Uses

Refer to the **Impact GW Res-1** discussion for the Extended Study Area. In addition, projects considered within the No Project/No Action Alternative are not located within the Primary Study Area, and therefore, **would not have a substantial adverse effect** on groundwater resources, when compared to Existing Conditions.

10.3.6 Impacts Associated with Alternative A

10.3.6.1 Extended Study Area – Alternative A

Construction, Operation, and Maintenance Impacts

Agricultural, Municipal, Industrial, and Wildlife Refuge Water Use

Impact GW Res-1: Substantial Depletion of Groundwater Supplies or Substantial Interference with Groundwater Recharge Resulting in a Net Deficit in Aquifer Volume or a Lowering of the Local Groundwater Table Level, Causing Effects on Existing Land Uses or Planned Uses

There would be no Project construction or maintenance activities in the Extended Study Area; therefore, there would be **no impact** on groundwater resources, when compared to Existing Conditions and the No Project/No Action Alternative. There would be no proposed Project operational activities or results from those activities that would result in a substantial depletion of groundwater supplies in the Extended Study Area. Improvement in surface water supply reliability for agricultural, municipal, and industrial water users as a result of the Project would reduce the need for extracting groundwater and/or provide some additional applied water for deep percolation recharge of the aquifer system; groundwater supplies would, therefore, not be depleted or reduced. Therefore, increased surface water supply reliability would have a **less-than-significant impact** on groundwater resources in the Extended Study Area, when compared to Existing Conditions and the No Project/No Action Alternative.

The provision of an alternate source of refuge water supply would not affect rates of groundwater use, and would, therefore, have **no impact** on groundwater resources, when compared to Existing Conditions and the No Project/No Action Alternative.

Impact GW Res-2: Increases in Groundwater Levels Resulting in Adverse Effects to Environmental Conditions and/or Existing Land Uses or Planned Uses

Refer to the **Impact GW Res-1** discussion for the Extended Study Area. Improvement in surface water supply reliability for agricultural, municipal, and industrial water users as a result of the Project could result in stabilization or modest increases in groundwater resources in CVP/SWP areas due to slightly increased recharge rates or a reduced need for groundwater extraction, but not at significant levels. Therefore, increased surface water supply reliability would have a **less-than-significant impact** on groundwater resources in the Extended Study Area, when compared to Existing Conditions and the No Project/No Action Alternative.

San Luis Reservoir

Impact GW Res-1: Substantial Depletion of Groundwater Supplies or Substantial Interference with Groundwater Recharge Resulting in a Net Deficit in Aquifer Volume or a Lowering of the Local Groundwater Table Level, Causing Effects on Existing Land Uses or Planned Uses

Operational modeling for Alternative A, when compared to Existing Conditions and the No Project/No Action Alternative, indicates that there would be continued water level fluctuations at San Luis Reservoir, but the fluctuations would occur more often and could be more severe. Severe reservoir level drawdowns could result in reduced seepage, which could reduce local groundwater recharge. However, San Luis Reservoir currently experiences severe water level fluctuations, and historic groundwater levels should not be substantially affected by continued fluctuations at an increased rate. Therefore, the increased fluctuations in water levels at San Luis Reservoir would have a **less-than-significant impact** on groundwater resources, when compared to Existing Conditions and the No Project/No Action Alternative.

Impact GW Res-2: Increases in Groundwater Levels Resulting in Adverse Effects to Environmental Conditions and/or Existing Land Uses or Planned Uses

Refer to the **Impact GW Res-1** discussion. Increased fluctuations in water levels at San Luis Reservoir would not increase groundwater levels, and would, therefore, have a **less-than-significant impact** on groundwater resources, when compared to Existing Conditions and the No Project/No Action Alternative.

10.3.6.2 Secondary Study Area – Alternative A

Construction, Operation, and Maintenance Impacts

Trinity Lake, Lewiston Lake, Trinity River, Klamath River Downstream of the Trinity River, Whiskeytown Lake, Spring Creek, Shasta Lake, Sacramento River, Keswick Reservoir, Clear Creek, Lake Oroville, Thermalito Complex (Thermalito Diversion Pool, Thermalito Forebay, and Thermalito Afterbay), Feather River, Sutter Bypass, Yolo Bypass, Folsom Lake, Lake Natoma, American River, Sacramento-San Joaquin Delta, Suisun Bay, San Pablo Bay, San Francisco Bay

Impact GW Res-1: Substantial Depletion of Groundwater Supplies or Substantial Interference with Groundwater Recharge Resulting in a Net Deficit in Aquifer Volume or a Lowering of the Local Groundwater Table Level, Causing Effects on Existing Land Uses or Planned Uses

There are no Project-related construction, operation, or maintenance activities that would result in a substantial depletion of groundwater supplies in the Secondary Study Area. Project operational activities would result in improved surface water storage in reservoir facilities within the Secondary Study Area, when compared to Existing Conditions and the No Project/No Action Alternative, which could increase infiltration that recharges groundwater in that area. Changes to the flow regime of the rivers, creeks, and bypasses could result in changes in the rate of groundwater recharge, but the amount of change is likely to be proportional to the change in flow, which is variable throughout the system. These changes are not expected to substantially affect groundwater recharge. Project diversions would not be expected to adversely affect groundwater recharge rates in areas where groundwater extraction has likely exceeded groundwater recharge because Project diversions would occur during periods of excess surface flows and storm events. Therefore, changes in reservoir storage and flow regime would have a **less-than-significant impact** on groundwater resources within the Secondary Study Area, when compared to Existing Conditions and the No Project/No Action Alternative. Construction, operation, and maintenance of an additional pump at the Red Bluff Pumping Plant would have **no impact** on groundwater resources, when compared to Existing Conditions and the No Project/No Action Alternative, because it would not extract groundwater.

Impact GW Res-2: Increases in Groundwater Levels Resulting in Adverse Effects to Environmental Conditions and/or Existing Land Uses or Planned Uses

Refer to the **Impact GW Res-1** discussion. Potential increased infiltration resulting from improved surface water storage could increase groundwater recharge rates. However, seepage is not expected to increase at a rate that would have a significant effect on groundwater resources. Therefore, changes in reservoir storage and flow regime would have a **less-than-significant impact** on groundwater resources within the Secondary Study Area, when compared to Existing Conditions and the No Project/No Action Alternative. Construction, operation, and maintenance of an additional pump at the Red Bluff Pumping Plant would have **no impact** on groundwater resources, when compared to Existing Conditions and the No Project/No Action Alternative, because it would not increase groundwater recharge.

10.3.6.3 Primary Study Area – Alternative A

Construction, Operation, and Maintenance Impacts

Sites Reservoir Inundation Area

Impact GW Res-1: Substantial Depletion of Groundwater Supplies or Substantial Interference with Groundwater Recharge Resulting in a Net Deficit in Aquifer Volume or a Lowering of the Local Groundwater Table Level, Causing Effects on Existing Land Uses or Planned Uses

Construction and the initial filling of Sites Reservoir would completely inundate both the Funks and Antelope Creek groundwater basins. Approximately 26 groundwater wells that are located in the inundation area would no longer be functional, but there would no longer be any use for the wells after the reservoir is inundated.

Operation and maintenance activities would result in a wide fluctuation of water stored in the Sites Reservoir during the year, when compared to Existing Conditions and the No Project/No Action Alternative. Similar to the impacts discussed in the construction section, this fluctuation would likely result in localized changes in groundwater recharge. Because of the limited groundwater use and infrastructure in the area surrounding the reservoir, the resulting impact would likely be undetectable. Therefore, construction, operation, and maintenance of Sites Reservoir would have a **less-than-significant impact** on groundwater resources, when compared to Existing Conditions and the No Project/No Action Alternative.

Impact GW Res-2: Increases in Groundwater Levels Resulting in Adverse Effects to Environmental Conditions and/or Existing Land Uses or Planned Uses

Refer to the **Impact GW Res-1** discussion. In addition, it is likely that, despite the grouting of the underlying rock formations, minimal amounts of water would leak from the reservoir and could increase groundwater recharge in nearby areas outside of the inundation area. However, groundwater use and infrastructure in the area surrounding the reservoir is very limited, and the permeability of the geologic material is generally low, so the impact to groundwater users and land use would likely be undetectable. Therefore, construction, operation, and maintenance of Sites Reservoir would have a **less-than-significant impact** on groundwater resources, when compared to Existing Conditions and the No Project/No Action Alternative.

Sites Reservoir Dams

Impact GW Res-1: Substantial Depletion of Groundwater Supplies or Substantial Interference with Groundwater Recharge Resulting in a Net Deficit in Aquifer Volume or a Lowering of the Local Groundwater Table Level, Causing Effects on Existing Land Uses or Planned Uses

Golden Gate Dam, Sites Dam, and the seven saddle dams would be located outside of the Funks and Antelope Creek groundwater basins. Sites and Golden Gate dams would be constructed on Stone Corral and Funks creeks, respectively; flows to those creeks would be maintained during construction. Some redirection of creek flows and stormwater management during construction may result in very minor redirection of groundwater recharge, when compared to Existing Conditions and the No Project/No Action Alternative. Operation and maintenance activities of the dam structures would not impede groundwater recharge. Therefore, the construction, operation, and maintenance activities associated with these dams would have **less-than-significant impact** on groundwater resources, when compared to Existing Conditions and the No Project/No Action Alternative.

Impact GW Res-2: Increases in Groundwater Levels Resulting in Adverse Effects to Environmental Conditions and/or Existing Land Uses or Planned Uses

Refer to the **Impact GW Res-1** discussion. Operation and maintenance activities of the dam structures would not significantly increase groundwater recharge. Therefore, the construction, operation, and maintenance activities associated with these dams would have **less-than-significant impact** on groundwater resources, when compared to Existing Conditions and the No Project/No Action Alternative.

Recreation Areas

Impact GW Res-1: Substantial Depletion of Groundwater Supplies or Substantial Interference with Groundwater Recharge Resulting in a Net Deficit in Aquifer Volume or a Lowering of the Local Groundwater Table Level, Causing Effects on Existing Land Uses or Planned Uses

The recreation areas would be located outside of the Funks and Antelope Creek groundwater basins, and no deep subsurface construction would be required; therefore, their development would result in **no impact** to groundwater resources, when compared to Existing Conditions and the No Project/No Action Alternative. Groundwater would not be used during the construction and maintenance of, or as a potable water source for, the recreation areas. Therefore, the construction, operation, and maintenance activities associated with the recreation areas would have **no impact** on groundwater resources, when compared to Existing Conditions and the No Project/No Action Alternative.

Impact GW Res-2: Increases in Groundwater Levels Resulting in Adverse Effects to Environmental Conditions and/or Existing Land Uses or Planned Uses

Refer to the **Impact GW Res-1** discussion.

Road Relocations and South Bridge

Impact GW Res-1: Substantial Depletion of Groundwater Supplies or Substantial Interference with Groundwater Recharge Resulting in a Net Deficit in Aquifer Volume or a Lowering of the Local Groundwater Table Level, Causing Effects on Existing Land Uses or Planned Uses

The construction, operation, and maintenance of these facilities would not require the use of groundwater and would not diminish groundwater recharge. Project construction may require temporary localized lowering of the shallow groundwater. However, the temporary lowering of groundwater levels would not impact current groundwater uses in the area because the groundwater levels would not be lowered enough or over a wide enough area to impact local groundwater users. These activities would, therefore, have **no impact** on groundwater resources, when compared to Existing Conditions and the No Project/No Action Alternative.

Impact GW Res-2: Increases in Groundwater Levels Resulting in Adverse Effects to Environmental Conditions and/or Existing Land Uses or Planned Uses

Refer to the **Impact GW Res-1** discussion. Temporary localized lowering of the groundwater would not increase groundwater levels. The construction, operation, and maintenance of these facilities would therefore have a **less-than-significant impact** on groundwater resources, when compared to Existing Conditions and the No Project/No Action Alternative.

Sites Pumping/Generating Plant, Electrical Switchyard, Tunnel, Reservoir Inlet/Outlet Structure, and Field Office Maintenance Yard

Impact GW Res-1: Substantial Depletion of Groundwater Supplies or Substantial Interference with Groundwater Recharge Resulting in a Net Deficit in Aquifer Volume or a Lowering of the Local Groundwater Table Level, Causing Effects on Existing Land Uses or Planned Uses

Construction of the Sites Pumping/Generating Plant, Sites Electrical Switchyard, Tunnel from Sites Pumping/Generating Plant to Sites Reservoir Inlet/Outlet Structure, and Sites Reservoir Inlet/Outlet Structure, and Field Office Maintenance Yard may require temporary localized lowering of the shallow groundwater. However, the temporary lowering of groundwater levels would not impact current groundwater uses in the area because the groundwater levels would not be lowered enough or over a wide enough area to impact local groundwater users. Therefore, the construction, operation, and maintenance of these facilities would have a **less-than-significant impact** on groundwater resources, when compared to Existing Conditions and the No Project/No Action Alternative.

Impact GW Res-2: Increases in Groundwater Levels Resulting in Adverse Effects to Environmental Conditions and/or Existing Land Uses or Planned Uses

Refer to the **Impact GW Res-1** discussion. Temporary localized lowering of the groundwater would not increase groundwater levels. Therefore, the construction, operation, and maintenance of these facilities would have a **less-than-significant impact** on groundwater resources, when compared to Existing Conditions and the No Project/No Action Alternative.

Holthouse Reservoir Complex, Holthouse Reservoir Electrical Switchyard, Terminal Regulating Reservoir Pipeline, and Terminal Regulating Reservoir Pipeline Road

Impact GW Res-1: Substantial Depletion of Groundwater Supplies or Substantial Interference with Groundwater Recharge Resulting in a Net Deficit in Aquifer Volume or a Lowering of the Local Groundwater Table Level, Causing Effects on Existing Land Uses or Planned Uses

Construction of the Holthouse Reservoir Complex would require the dredging of the existing Funks Reservoir. Dredging activities would require the dewatering of Funks Reservoir for two years, which would likely result in a short-term reduction in groundwater recharge in the local area. The reduction would be small because permeability of the underlying material is low. It is unlikely that it would affect groundwater users because groundwater quantity is low. DWR records only indicate two wells within a mile radius of Funks Reservoir. Therefore, there would be a **less-than-significant impact** on groundwater resources from the dredging of Funks Reservoir, when compared to Existing Conditions and the No Project/No Action Alternative.

Construction of the Holthouse Reservoir Complex facilities, Holthouse Reservoir Electrical Switchyard, TRR Pipeline, and TRR Pipeline Road may require temporary localized lowering of the shallow groundwater in the construction area. However, the temporary lowering of groundwater levels would not impact current groundwater uses in the area because the groundwater levels would not be lowered enough or over a wide enough area to impact local groundwater users. Construction of the Holthouse Reservoir Complex would, therefore, result in a **less-than-significant impact** on groundwater resources, when compared to Existing Conditions and the No Project/No Action Alternative.

Impact GW Res-2: Increases in Groundwater Levels Resulting in Adverse Effects to Environmental Conditions and/or Existing Land Uses or Planned Uses

Refer to the **Impact GW Res-1** discussion. Dewatering Funks Reservoir would not increase groundwater levels. Therefore, there would be a **less-than-significant impact** on groundwater resources from the dredging of Funks Reservoir, when compared to Existing Conditions and the No Project/No Action Alternative.

Inundation of Holthouse Reservoir would likely lead to higher groundwater levels in a localized area around the reservoir. There are three constructed wells within an approximately one-mile radius of the proposed Holthouse Reservoir. They are located to the north and northeast of the reservoir area. There is limited groundwater flow direction data for the area, but regional trends indicate groundwater flow is in an easterly to southeasterly direction. This trend indicates that it is unlikely that higher groundwater levels would be experienced in the three wells.

It is likely that groundwater levels would increase in the areas immediately south and southeast of the proposed Holthouse Reservoir during Project operation. There are identified sensitive wetlands and orchard crops in the areas that would likely experience an increase in groundwater levels. The groundwater levels could be increased enough to adversely impact wetland hydrology and water chemistry and agricultural operations in these areas. Construction, operation, and maintenance of the Holthouse Reservoir Complex would result in a **potentially significant impact** on groundwater resources south and southeast of Holthouse Reservoir, when compared to Existing Conditions and the No Project/No Action Alternative.

Glenn-Colusa Irrigation District Canal Facilities Modifications

Impact GW Res-1: Substantial Depletion of Groundwater Supplies or Substantial Interference with Groundwater Recharge Resulting in a Net Deficit in Aquifer Volume or a Lowering of the Local Groundwater Table Level, Causing Effects on Existing Land Uses or Planned Uses

Construction of the new GCID Canal headgate structure may require temporary localized lowering of the shallow groundwater to allow for the installation of underground equipment in the construction area. The temporary lowering of groundwater levels would not impact current groundwater uses in the area because the groundwater levels would not be lowered enough or over a wide enough area to impact local groundwater users. Construction, operation, and maintenance of the GCID Canal headgate structure would have a **less-than-significant impact** on groundwater resources, when compared to Existing Conditions and the No Project/No Action Alternative.

Impact GW Res-2: Increases in Groundwater Levels Resulting in Adverse Effects to Environmental Conditions and/or Existing Land Uses or Planned Uses

Refer to the **Impact GW Res-1** discussion. Temporary localized lowering of the groundwater would not increase groundwater levels. Therefore, the construction, operation, and maintenance of the GCID Canal headgate would have a **less-than-significant impact** on groundwater resources, when compared to Existing Conditions and the No Project/No Action Alternative.

Terminal Regulating Reservoir, Terminal Regulating Reservoir Pumping/Generating Plant, Terminal Regulating Reservoir Electrical Switchyard, and the Glenn-Colusa Irrigation District Canal Connection to the Terminal Regulating Reservoir

Impact GW Res-1: Substantial Depletion of Groundwater Supplies or Substantial Interference with Groundwater Recharge Resulting in a Net Deficit in Aquifer Volume or a Lowering of the Local Groundwater Table Level, Causing Effects on Existing Land Uses or Planned Uses

Construction of the TRR, TRR Pumping/Generating Plant, TRR Electrical Switchyard, and the GCID Canal Connection to the TRR (an energy dissipation bay and inlet channel) may require temporary localized lowering of the shallow groundwater to allow for the installation of underground equipment in the construction area. Temporary lowering of groundwater levels would not impact current groundwater uses in the area because the groundwater levels would not be lowered enough or over a wide enough area to impact local groundwater users. Inundation of the reservoir would likely increase groundwater recharge and lead to higher groundwater levels in a localized area around the reservoir, and therefore, would not result in reduced groundwater supplies. Construction, operation, and maintenance of these facilities would, therefore, have a **less-than-significant impact** on groundwater resources, when compared to Existing Conditions and the No Project/No Action Alternative.

Impact GW Res-2: Increases in Groundwater Levels Resulting in Adverse Effects to Environmental Conditions and/or Existing Land Uses or Planned Uses

Refer to the **Impact GW Res-1** discussion. Filling of the reservoir would likely increase groundwater recharge and lead to higher groundwater levels in a localized area around the reservoir. There are three constructed wells within an approximately one-mile radius of the proposed TRR. They are located in sections north and northeast of the reservoir area. There is limited groundwater flow direction data for the area, but regional trends indicate groundwater flow is in an easterly to southeasterly direction. This trend indicates that it is unlikely that higher groundwater levels would be experienced in the three wells.

It is likely that groundwater levels would increase in the areas immediately south and southeast of the TRR. There are rice, grain, and orchard crops in the areas that would likely experience the increase in groundwater levels. The groundwater levels could be increased enough to adversely impact the agricultural operations in these areas. Construction, operation, and maintenance of the TRR would result in a **potentially significant impact** on groundwater resources surrounding the TRR (especially along the south and southeast sides), when compared to Existing Conditions and the No Project/No Action Alternative.

Delevan Pipeline, Delevan Transmission Line, and Delevan Pipeline Electrical Switchyard

Impact GW Res-1: Substantial Depletion of Groundwater Supplies or Substantial Interference with Groundwater Recharge Resulting in a Net Deficit in Aquifer Volume or a Lowering of the Local Groundwater Table Level, Causing Effects on Existing Land Uses or Planned Uses

Construction of the Delevan Pipeline, Delevan Pipeline Electrical Switchyard, and Delevan Transmission Line tower footings may require temporary localized lowering of the shallow groundwater to allow for the installation of underground equipment in the construction area. The temporary lowering of groundwater would not impact current groundwater uses in the area because the groundwater levels would not be lowered enough or over a wide enough area to impact local groundwater users. Construction, operation, and maintenance of the Delevan Pipeline, Delevan Transmission Line, and Delevan Pipeline Electrical Switchyard would, therefore, have a **less-than-significant impact** on groundwater resources, when compared to Existing Conditions and the No Project/No Action Alternative.

Impact GW Res-2: Increases in Groundwater Levels Resulting in Adverse Effects to Environmental Conditions and/or Existing Land Uses or Planned Uses

Refer to the **Impact GW Res-1** discussion. Temporary localized lowering of the groundwater would not increase water levels, and therefore, would have a **less-than-significant impact** on groundwater resources, when compared to Existing Conditions and the No Project/No Action Alternative.

Delevan Pipeline Intake Facilities

Impact GW Res-1: Substantial Depletion of Groundwater Supplies or Substantial Interference with Groundwater Recharge Resulting in a Net Deficit in Aquifer Volume or a Lowering of the Local Groundwater Table Level, Causing Effects on Existing Land Uses or Planned Uses

Construction, operation, and maintenance of the Delevan Pipeline Intake Facilities would include construction of a forebay facility at the proposed intake location. It is likely that groundwater levels would increase in the areas around the forebay after it is filled. Consequently, groundwater resources would not be reduced or depleted. Construction, operation, and maintenance of the Delevan Pipeline Intake Facilities would result in a **less-than-significant impact** to groundwater resources, when compared to Existing Conditions and the No Project/No Action Alternative.

Impact GW Res-2: Increases in Groundwater Levels Resulting in Adverse Effects to Environmental Conditions and/or Existing Land Uses or Planned Uses

Refer to the **Impact GW Res-1** discussion. There are orchard crops located in the areas that would likely experience the increase in groundwater levels. Groundwater levels could be increased enough to adversely impact the agricultural operations in this area.

Construction, operation, and maintenance of the Delevan Pipeline Intake Facilities would, therefore, result in a **potentially significant impact** to groundwater resources in the areas directly surrounding the forebay facility, when compared to Existing Conditions and the No Project/No Action Alternative.

Project Buffer

Impact GW Res-1: Substantial Depletion of Groundwater Supplies or Substantial Interference with Groundwater Recharge Resulting in a Net Deficit in Aquifer Volume or a Lowering of the Local Groundwater Table Level, Causing Effects on Existing Land Uses or Planned Uses

Within the Project Buffer, some structures would be demolished, and any agricultural fields that are currently irrigated may not continue to receive irrigation. Any wells associated with those structures or used as irrigation sources may, therefore, no longer be used. The discontinued use of any wells could increase, rather than decrease, groundwater supplies. Therefore, there would be **no impact**, when compared to Existing Conditions and the No Project/No Action Alternative.

Impact GW Res-2: Increases in Groundwater Levels Resulting in Adverse Effects to Environmental Conditions and/or Existing Land Uses or Planned Uses

Refer to the **Impact GW Res-1** discussion. The potential reduction in groundwater extraction rates related to the discontinued use of wells could increase groundwater supplies, but not by enough or over a wide enough area to impact local groundwater levels. Therefore, the acquisition of land within the Project Buffer would have a **less-than-significant impact** on groundwater resources, when compared to Existing Conditions and the No Project/No Action Alternative.

10.3.7 Impacts Associated with Alternative B

10.3.7.1 Extended Study Area – Alternative B

Construction, Operation, and Maintenance Impacts

The impacts associated with Alternative B, as they relate to groundwater supplies and recharge (**Impact GW Res-1**) and groundwater levels (**Impact GW Res-2**) would be the same as described for Alternative A for the Extended Study Area.

10.3.7.2 Secondary Study Area – Alternative B

Construction, Operation, and Maintenance Impacts

The impacts associated with Alternative B, as they relate to groundwater supplies and recharge (**Impact GW Res-1**) and groundwater levels (**Impact GW Res-2**) would be the same as described for Alternative A for the Secondary Study Area.

10.3.7.3 Primary Study Area – Alternative B

Construction, Operation, and Maintenance Impacts

The following Project facilities are included in both Alternatives A and B. These facilities would require the same construction methods and operation and maintenance activities regardless of alternative, and would, therefore, result in the same construction, operation, and maintenance impacts to groundwater resources:

- Recreation Areas
- Sites Pumping/Generating Plant

- Sites Electrical Switchyard
- Tunnel from Sites Pumping/Generating Plant to Sites Reservoir Inlet/Outlet Structure
- Sites Reservoir Inlet/Outlet Structure
- Field Office Maintenance Yard
- Holthouse Reservoir Complex
- Holthouse Reservoir Electrical Switchyard
- GCID Canal Facilities Modifications
- GCID Canal Connection to the TRR
- TRR Pumping/Generating Plant
- TRR Electrical Switchyard
- TRR Pipeline
- TRR Pipeline Road
- Delevan Pipeline
- Delevan Pipeline Electrical Switchyard

If Alternative B is implemented, the footprint and construction disturbance area of Sites Reservoir and Dams, the Road Relocations and South Bridge, and the Delevan Transmission Line would differ from Alternative A. In addition, the Delevan Pipeline Intake Facilities would be replaced by the Delevan Pipeline Discharge Facility. The boundary of the Project Buffer would be the same for Alternatives A and B, but because the footprints of some of the Project facilities that are included in the Project Buffer would differ between the alternatives, the acreage of land within the Project Buffer would also differ. However, these differences in the size of the facility footprint, alignment, or construction disturbance area would not change the type of construction, operation, and maintenance activities that were described for Alternative A. They would, therefore, have the same impact on groundwater supplies and recharge (**Impact GW Res-1**) and groundwater levels (**Impact GW Res-2**) as described for Alternative A, with the exclusion of the potential impacts associated with the Delevan Pipeline Intake Facility forebay and afterbay that are included in Alternative A, but not Alternative B.

10.3.8 Impacts Associated with Alternative C

10.3.8.1 Extended Study Area – Alternative C

<u>Construction, Operation, and Maintenance Impacts</u>

The impacts associated with Alternative C, as they relate to groundwater supplies and recharge (**Impact GW Res-1**) and groundwater levels (**Impact GW Res-2**) would be the same as described for Alternative A for the Extended Study Area.

10.3.8.2 Secondary Study Area – Alternative C

<u>Construction, Operation, and Maintenance Impacts</u>

The impacts associated with Alternative C, as they relate to groundwater supplies and recharge (**Impact GW Res-1**) and groundwater levels (**Impact GW Res-2**) would be the same as described for Alternative A for the Secondary Study Area.

10.3.8.3 Primary Study Area – Alternative C

Construction, Operation, and Maintenance Impacts

The following Primary Study Area Project facilities are included in Alternatives A, B, and C. These facilities would require the same construction methods and operation and maintenance activities regardless of alternative, and would, therefore, result in the same construction, operation, and maintenance impacts to groundwater resources:

- Recreation Areas
- Sites Pumping/Generating Plant
- Sites Electrical Switchyard
- Tunnel from Sites Pumping/Generating Plant to Sites Reservoir Inlet/Outlet Structure
- Sites Reservoir Inlet/Outlet Structure
- Field Office Maintenance Yard
- Holthouse Reservoir Complex
- Holthouse Reservoir Electrical Switchyard
- GCID Canal Facilities Modifications
- GCID Canal Connection to the TRR
- TRR Pumping/Generating Plant
- TRR Electrical Switchyard
- TRR Pipeline
- TRR Pipeline Road
- Delevan Pipeline
- Delevan Pipeline Electrical Switchyard

The Alternative C design of the Delevan Transmission Line and Delevan Pipeline Intake Facilities is the same as described for Alternative A. These facilities would require the same construction methods and operation and maintenance activities regardless of alternative, and would, therefore, result in the same construction, operation, and maintenance impacts to groundwater supplies and recharge (**Impact GW Res-1**) and groundwater levels (**Impact GW Res-2**) as described for Alternative A.

The Alternative C design of the Sites Reservoir Inundation Area and Dams, Recreation Areas, and Road Relocations and South Bridge is the same as described for Alternative B. These facilities would require the same construction methods and operation and maintenance activities regardless of alternative, and would, therefore, result in the same construction, operation, and maintenance impacts to groundwater supplies and recharge (**Impact GW Res-1**) and groundwater levels (**Impact GW Res-2**) as described for Alternative B.

The boundary of the Project Buffer would be the same for all three alternatives, but because the footprints of some of the Project facilities that are included in the Project Buffer would differ between the alternatives, the acreage of land within the Project Buffer would also differ. However, these differences in the size of the area included within the buffer would not change the type of construction, operation, and maintenance activities that were described for Alternative A. They would, therefore, have the same impact on groundwater supplies and recharge (**Impact GW Res-1**) and groundwater levels (**Impact GW Res-2**) as described for Alternative A.

10.4 Mitigation Measures

Mitigation measures are provided below and summarized in Table 10-6 for the impacts that have been identified as significant or potentially significant.

Table 10-6
Summary of Mitigation Measures for
NODOS Project Impacts to Groundwater Resources

Impact	Associated Project Facility	LOS Before Mitigation	Mitigation Measure	LOS After Mitigation
Impact GW Res-2: Increases in Groundwater Levels Resulting in Adverse Effects to Environmental Conditions and/or Existing Land Uses or Planned Uses	Holthouse Reservoir Complex, TRR, Delevan Pipeline Intake Facilities	Potentially Significant	Mitigation Measure GW Res-2: Monitor and Lower Groundwater Levels as Necessary	Less than Significant
	Holthouse Reservoir	Potentially Significant	Mitigation Measure Bot-1e: Minimize Impacts by Siting Facilities Away from Drainage Swales and using BMPs; Conduct Hydrological Studies and Implement Vegetation Community Mitigation Measures Recommended by USFWS	Less than Significant or Potentially Significant and Unavoidable

Note:
LOS = Level of Significance

Mitigation Measure GW Res-2: Monitor and Lower Groundwater Levels as Necessary

To minimize impacts to existing land uses from the expected increase in groundwater levels from the development of the Holthouse Reservoir Complex, the TRR, and the Delevan Pipeline Intake Facilities, groundwater level monitoring wells shall be installed around these facilities prior to filling of the reservoirs and forebay to provide existing groundwater level data for these areas. The wells shall be monitored throughout Project operation to determine changes in groundwater levels. Shallow groundwater return wells or French Drains with pumps shall be installed to pump groundwater and return it to the reservoirs and forebay if it is determined necessary to lower the groundwater levels.

Mitigation Measure Bot-1e: Minimize Impacts by Siting Facilities Away from Drainage Swales and using BMPs; Conduct Hydrological Studies and Implement Vegetation Community Mitigation Measures Recommended by USFWS

- DWR and Reclamation shall implement measures that mitigate impacts to alkaline wetland vegetation in the on-site swale to avoid sedimentation of the swale during Project construction, according to recommendations received during consultation with USFWS. DWR and Reclamation shall conduct studies to determine the importance of the headwaters of the swale to the health of the swale and the downstream alkaline marsh.
- DWR and Reclamation shall conduct studies to determine the effects of groundwater pressure on the health of the swale and the marsh. Measures may include protection of nearby similar vegetation

communities, or USFWS may determine the effects are unavoidable and there may be no means of mitigation if there are no equivalent nearby vegetation communities that are feasible to protect or enhance.

Implementation of **Mitigation Measure GW Res-2** would reduce the level of significance of Project impacts to groundwater resources to **less than significant**.

Implementation of **Mitigation Measure Bot-1e** would reduce the level of significance of Project impacts to groundwater resources to **less than significant,** or they would remain **potentially significant and unavoidable.**

10.5 References

California Department of Water Resources. (DWR). 2011. Unpublished 2011 Well Completion Report Data.

California Department of Water Resources. (DWR). 2003. Bulletin 118-03 California's Groundwater. 246p. pp 108, 122, 131, 140, 149, 159, 169, 177, 194, 204.